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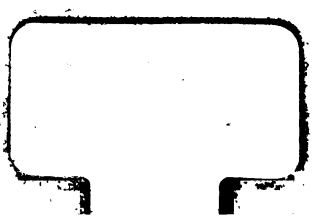

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From Pres. Angell

SOME SPECULATIONS

IN REGARD TO THE

METEORIC MATTER IN SPACE

AND ITS

RELATION TO COMETS

AND

THE FIXED STARS.

By W. P. MORE.

KINGSTON, N. Y.

1897.

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METEORIC MATTER.

In this article, under the term "Meteoric Matter," I shall include, together with those fragments or unbroken bodies which occasionally reach the earth from celestial space, all of those other bodies which become visible when they come in contact with the air, and are known as Meteors, Aerolite, Bolides, Shooting Stars, etc., accordingly as they vary in appearance, while during the twinkling of an eye they drop into our atmosphere and are consumed or pass through it out into space, and look while passing like falling stars, streams of fire and brilliant fireballs. All of these I assume are only the representatives of similar bodies which are moving in countless numbers, in orbits or otherwise, in celestial space, and become visible only when they are glowingly heated by their impact and friction with the air as they plunge into or through it when moving with great velocity.

The heat which is thus developed must in most cases be so intense that it converts a portion of each of these larger bodies and the whole of the smaller ones into their gaseous elements; because there is but an extremely small percentage of those which become visible that reach the earth as solid bodies, and many of them leave for a few seconds or minutes a luminous, fiery train behind, which can be nothing but the product of their combustion. I conclude that such must be the fact, because, although the air too must become highly heated, there is no amount of heat, so far as we know, that can make air of itself luminous.

Celestial space is so filled with this matter that every day

and hour, everywhere in the great circuit of its annual orbit, the earth is being bombarded—as it runs the gauntlet, so to speak—with these bodies, which are crossing its path and plane of its orbit in every conceivable direction.

The following extract from Prof. Herbert A. Newton's article on meteors in Encyclopædia Britannica, vol. xvi, page 109, will give us an idea of their numbers. He says: "Any person who should in a clear moonless night watch "carefully a portion of the heavens, would in the mean see "at least as many as eight or ten shooting stars an hour. "A clear-sighted and practical observer would detect some- "what more than this number. Dr. Schmidt, of Athens, "from observations during seventeen years, obtained four- "teen as the mean hourly number on a clear moonless night "for one observer during the hours from midnight to one "A. M. A large group of observers, as has been shown by "trial, would see at least six times as many as a single per- "son. By a proper consideration of the distribution of "meteoric paths over the sky, and in actual altitudes in "mile, so as to allow for mists near the horizon, it appears "that the number over the whole globe is a little more than "ten thousand times as many as can be seen in one place. "This implies that there comes into the air not less than "twenty millions of bodies daily, each of which under favor- "able conditions of absence of sunlight, moonlight, clouds "and mists, would furnish a shooting star visible to the "naked eye. Shooting stars invisible to the naked eye are "often seen in the telescope. The number of meteors if "these are included would be increased at least twenty "fold." (Which would be respectively not less than 800,000 and 16,000,000 per hour.) Now the earth moves in its annual orbit at the rate of about 68,000 miles an hour. But there is no reason to suppose it intercepts more of these bodies because of that movement than if it remained in one place. Those it overtakes in its forward motion of about twenty miles a second would be balanced by those which would overtake it were it standing still. Then, if these bodies are moving at the average rate of twenty miles a

second, which is supposed to be about their velocity, we can closely estimate about how many of them in the mean are moving at any one time within a globe of space that equals the earth in volume, supposing that to be 8,000 miles in diameter. Under these conditions it would take each of them 6 $\frac{2}{3}$ minutes to pass through the whole diameter of such globe. But let us add one-half to such a scope of space so as to form—which it would—a cylindrical scope of space 8,000 miles long and 8,000 miles in diameter, it would then take each of such bodies as are at any moment moving in a space that equals the earth in diameter, 6$\frac{2}{3}$ minutes to pass through the *whole length* of such cylinder. And since a globe which equals the earth would equal $\frac{2}{3}$ of such cylindrical space, the average time required for each of those bodies, which the earth encounters hourly, to pass through it would be $\frac{2}{3}$ the time it takes them to pass through the whole length of such cylinder, which would be 4$\frac{4}{9}$ minutes. But in this speculative view, for convenience, I will make some figures on a lower basis, and will suppose it takes these bodies in the mean only four minutes to pass through this space; in such case there would be one-fifteenth as many moving at any one time within a globe of space which equals the earth in volume as the earth encounters while moving one hour in its orbit, which shows them to be so numerous that there are on the average over 50,000 of such as become visible to the naked eye, and over 1,000,000 if we add those which the telescope brings to view, that are moving within such a portion of space.

It is a fair presumption that every such volume of space, within the bounds of the solar system at least, is pervaded on the average with a like number of these bodies, since they cross the earth's path everywhere in the 570,000,000 miles circuit of its annual orbit, or wherever it may be carried by the sun through untold millions of miles in the heavens.

When we consider from our close standpoint these numbers—50,000 or 1,000,000—that pervade this space, the latter is so extensive that were they evenly distributed therein each

individual of these 5,000 would be more than 170 miles from its nearest neighbor, while each of the million bodies would be nearly sixty-four miles from each other. And as these meteors only occasionally appear, so as to attract our especial attention, under the most favorable conditions of a dark and cloudless night, they may appear insignificant and of no account because they are so diminutive and widely scattered. But the aspect becomes far different when we consider the number that pervades the space, equal in volume to the planet Jupiter, and at *that distance* from our point of view.

When nearest to us, that planet is in round numbers 380,000,000 miles away, and appears to the unassisted eye only a brilliant point of light, yet its volume is over 1,230 times that of the earth, and its equivalent of space, which appears to us at that distance but a point, would be invaded by over 61,000,000 of these larger bodies, and over 1,220,000,000 if we include these telescopic or smaller meteors. But in this case we are considering only this apparent speck or atom of space, but its equivalent in the great beyond, and the hither side, and the wide expanse of space everywhere may be supposed to be equally as full of these fragments, which, when viewed from a standpoint that is many millions of miles distant, may be compared in point of numbers far more numerous than the particles of dust and smoke which pervade an *apparently* similar small speck of space in our surrounding air. And in this comparative view these meteors may with propriety be classed as only dust in space. Because these bodies appear to be universally distributed and are flittering everywhere, it may be suspected that the shimmering, twinkling appearance of the Fixed Stars may be caused by the flight of these meteors across their rays, which for a moment partially obscure their light.

These threads or points of light which come down to us from these stars are transmitted through so vast a distance that the greatest magnifying power of our telescopes show them only as brilliant points of light, no larger in apparent magnitude than that class of meteors—which are popularly

termed falling or shooting stars—appear to the naked eye.

A wonderful fact in regard to these fixed stars is that they appear just as large, when viewed across the earth's orbit, as when six months later we are 180,000,000 of miles nearer the same stars. And when viewed from thence through our most powerful telescopes, which should reduce their *apparent* distance by untold hundreds of millions of miles, they still appear no larger, but remain the same immeasureable points. And if a telescope were sufficiently powerful to show us the moon, as if it were only 50 or 80 miles away or at the distance from us that the most of these shooting stars are visible, and failed—which it probably would—to show the light from these stars anything more than brilliant points, then such meteors as these which become visible to the naked eye when crossing these pencils of light would cause them to flicker when such transit occurs many thousands of miles, even as far as the moon is away. And the transit centrally across any one of these rays, of any one of these meteors when that is no more than 50 or 80 miles away, would cause a momentary total eclipse of its light. It is therefore believed to be by no means a stretch of the imagination to assume that the transit, even of these diminutive telescopic bodies across such finite pencils of light would cause them to flicker, though such transit might occur thousands of miles away. And the flitting across these rays of any one of the more than 60,000 meteors, such as become *visible* to the naked eye and which invade in such numbers a conical portion of space such as lies between us and the moon, would cause these lights to flicker when crossing them anywhere not further from us than the moon.

A conundrum that is difficult to answer satisfactorily is, how did these smaller asteroids and meteoric matter become distributed in space? Are they disintegrated comets, or are they the debris or fragments of exploded suns and planets? Or do they represent simply the early condition of matter which from the *incomprehensibly remote* past has been slowly but surely collecting into and building up worlds, planets and suns?

This latter condition has certainly been contributing to the earth during every year of its historic period no inconsiderable quantity of solid matter, which corresponds in its elementary composition with the average material of the earth, to which must be added also the gases from those meteors which have been wholly or partly consumed in the air, and which must have finally settled to the surface.

The writer fortunately had a view of the brilliant meteoric display which occurred in November, 1833. The magnificence of that scene—to say nothing of the terror which it produced—was beyond description. The whole dome of the sky was literally filled with these heavenly fireworks. And a large percentage of those meteors left trains of light behind which could have been nothing but the brilliantly heated smoke and gas thrown off from their consumed or partially consumed bodies. This, however, was an uncommon occurrence. But each individual of the millions which on the average enter the earth's atmosphere daily with such velocity that they become glowingly heated leave some though it be but a finite part of their substance behind. The average addition to the globe of this gaseous and solid matter, though that may have been but a few thousand tons, or a few thousand pounds, or even but a few hundred pounds annually, could easily have gathered materials sufficiently in the vast passed eternity of epochs, ages and years to have formed a world like ours.

If we accept the conclusions of Dr. Schmidt in his work, as to the number of meteors which the earth encounters daily, when there is no extraordinary display of *falling* stars, his numbers would require to be multified at least ten thousand times to show how densely a portion of space was occupied by that November *shower*.

As regards the size of these bodies I have no speculative ideas, except however, judging from the best attainable data, that they seldom appear nearer than thirty miles to the surface and some are as distant as eighty miles, the smaller of those in order to become visible to the naked eye even when heated to a white heat must be at least a large fraction

of an inch in diameter. The only definite knowledge we have of them is that the fragments—of the largest known of these objects which have fallen to the ground—would aggregate in heft but a few thousand pounds.

In fact, all we know of these bodies we have learned through their neighborly habit of entering our atmosphere and occasionally falling to the surface. Their existence beyond the air only for this would have remained to us as a sealed book, since—unless the recently discovered asteroids may be classed with the larger of these bodies—no telescope reveals their presence beyond the atmosphere.

From what we have learned of these bodies as the earth has met them in the *comparatively narrow thread* of space through which it moves in its annual orbit, we may safely speculate that in numerous sections of the wide expanse of celestial space they may be collected in such enormous numbers that when making their perihelion passage in their orbits around the sun, their interposition between that and the earth which might be continued for days and weeks would intercept a percentage of the sun's heat sufficiently large to seriously affect the temperature of the earth. Even the numbers in the Leonides system through the orbit of which the earth passed which caused the November showers of 1833 and 1866, if they should when returning from their perihelion in this orbit be moving close to the sun and between that and the earth—say, in the space that is between 5,000,000 and 6,000,000 miles from the center of the sun—they would certainly under such condition materially affect its temperature.

For, such space which would contain 2,252,000 times the volume of the earth would be invaded by over 22,000,000,000,000,000 of these bodies. But the plane of the great circle of the earth—that is, the plane passing through its center at the equator, contains in round numbers less than 201,790,000,000,000,000 square inches. So that if each of these bodies should in the mean arrest no more light and heat from the sun than falls on a square inch of surface, their aggregate numbers would shade over ten per cent. of that heat from the earth. And, if sufficiently large to avert the heat that

falls on a surface of two and a half square inches, they would intercept one quarter of that heat. And certainly if these blocks of stone, or whatever they are, were smaller than that, it would seem that they would be invisible, even when heated to a white heat when they are 80, 50 or 30 miles away, which is the reputed distance above the surface at which the most of these falling stars are supposed to appear. When we take into account all of these conditions, we find that these almost unnoticed and apparently insignificant meteors loom up into a possible meteorological factor of no mean proportions. So much so that some of the marked difference between cold and warm seasons may be the direct result of their interposition in greater or *lesser numbers* between the sun and the earth.

The known fact that this matter is not distributed uniformly through the solar system, the proof of which consists in *such showers* as appeared in 1833 and 1866 when coupled with the probability that many of them are moving in orbits around the sun or the planets, leads us to speculate that the dominion of the fixed stars may not be exempt from their invasion. And that possibly the peculiar appearance of what are known as variable stars—because they change in brilliancy—may be occasioned by dense clouds of meteoric matter, which, when revolving in orbits around these distant suns may occupy briefly such a position as to eclipse or partially obscure their light.

The literature that is extant on comets abounds with speculations that they are in some way allied closely with these bodies. Some of these theories—supposes that the nuclei of some comets are composed of great numbers of closely aggregated yet by no means a compact or solid mass of these bodies. One assumption is that those streams of meteors in 1833 and 1866, which the earth encountered in great numbers in November of those years, and in lesser numbers in one and two years before and after those dates, was what was formerly a well defined comet—which has finally failed to reappear—whose orbit had a period of thirty-three years and moved through space in nearly the same

track that these streams of meteors are supposed to pursue; and that that comet—or stream of meteors—has finally become stretched through so many hundreds of millions of miles that the earth when crossing its track meets them at about the same date for three or four successive seasons.

It is not my purpose to occupy space in explaining all the various theories in regard to comets which have been put forth. The speculations of astronomers in respect to that branch of the science though intensely interesting are enshrouded in much obscurity and uncertainty. And aside from the known movements of a very small percentage of their numbers the only real knowledge we have of them is that they are extremely light bodies, that is, they are of small specific gravity, because they produce no perceptible disturbing influence on the motion of any of the planets when passing near them. This is a condition which suggests that their substance is of a gaseous nature. Laplace computed that the comet of 1770, which came within 1,400,000 miles of the earth and passed through the paths of Jupiter's moons without disturbing their movements, must have been less than $\frac{1}{5000}$ part of the heft of the earth, as it produced no sensible effect on its motion. And it is worthy of remembrance and particular notice that that comet had a visible ~~meteor~~ nucleus that was 203,000 miles in diameter; and its apparent diameter when nearest the earth was nearly sixteen times that of the moon. But that comet may have been an exceptional one. for since they vary largely in appearance they may also vary in density. But, that their nuclei may be described as vanity, accords with the unanimous sentiment of astronomers who have given them much investigation. Some comets are attended with long trains or tails of light, while others show but small or short trains, all of which invariably extend out from them opposite to the sun, or nearly so, and increase in length and brilliancy the nearer they approach to it, but some of them have no tails. Telescopic comets—those which are only seen through the telescope—are largely of the latter class, which implies that they are comparatively small bodies, or if large are so far from the

sun when at perihelion that it has too little force to eject out beyond them, the light, electricity or whatever the luminous property may be which forms their trains. Their nuclei or heads—which are the real comets—present in some cases the appearance of a faintly luminous nebulæ which is so transparent that it is said that stars of the tenth magnitude—which are visible only through the telescope—may be seen through them, their light being not in the least dimmed by its passage through them.

But it is that class of comets which are attended with trains of light that usually increase in length and brilliancy, stretching in some cases to immense proportions when approaching the sun in their orbits, which have attracted my special notice. A noted example of this was the comet of 1843, which impressed me as showing in its appearance a close relationship of all that class of comets with this meteoric matter, while in fact this matter of itself forms no part—except in appearance—of the actual comet. The explanation of this apparent enigma is, that the comet itself is probably an immense globe of transparant gas, which refracts or so concentrates the sun's rays which pass through it that where they stream out beyond it, this concentrated light illuminates and makes visible a streak of this meteoric dust. Such being probably the case, this streak of light, which we associate with it in name, forms no part of the real comet. It is only the reflection of this concentrated sunlight from this matter which we see and call the comet's tail. This train of illuminated matter is not carried with the comet, but as that moves in its orbit this stream of concentrated light swings round beyond it from the sun, so that new portions of this dust which exist with varying density everywhere in space is being every instant lighted up and as quickly left in the dark behind.

The effect of this concentrated light on this matter in space is precisely the same as when a ray of sun light enters a darkened room, in bringing to view a streak of otherwise invisible dust, or like the streaks of smoke and dust which are popularly termed "the sun drawing water," which are made

visible by the sun light that passes through openings in the clouds.

The principal reason why the great comet of 1843 impressed me with the idea that the tails of comets are nothing more than light *made visible*, was because the extreme end of its tail which reached out more than 200,000,000 of miles beyond it sweeped around in that great radius, and continued to stream out nearly opposite to the sun from the comet while that moved through 180° of its orbit—half around the sun—in less than two hours. Surely, the flight of this illuminated train could be satisfactorily explained by no known theory except that of the rapid transmission of light. If it is such concentrated light that brings to our view a streak of this celestial dust by its contrast with the surrounding matter, which is illuminated by only the ordinary diffused rays of the sun and gives to the sky its uniform shading. it follows that some of this light so gathered is taken from or robs the closely surrounding matter of the light which gives it its usual color, and by this darkening that makes the lighted dust in contrast with it more marked. This theory would also seem to require that all comets which have tails of much length must be as large or larger than the sun, or, if smaller, must pass close to it, to gather sufficient light to thus illuminate this matter.

We know that the refractive influence of our atmosphere on the light of the sun, which passes into or through it, has a concentrating tendency on its rays, because its light is not entirely shut off, as is indicated by the lingering twilight until it has dropped nearly fifteen degrees below the horizon. And when the moon is totally eclipsed the refraction of the sun's rays by the thin stratum of gas which surrounds the earth, though that be darkened by smoke and mist, still concentrates or bends sufficient light upon the moon to prevent its entire obscurity.

I am aware that some scientists claim that no body wholly gaseous can exist in space. While neither the truth or fallacy of this statement is susceptible of positive proof, the fact that all known gases have weight is sufficient proof to

me that if any one of them were eliminated in space its gravity would counteract somewhere its disposition—if it has such—to expand infinitely. Futhermore, its heft would cause it to be governed by the same laws of motion that govern solid bodies, and its density would vary like our atmosphere; its central parts would be dense while its outermost parts would be alternated to inconceivable thinness. And, moreover, it would be entirely invisible in appearance. But let us assume the theory to be correct, that gas is incapable of holding itself together by its own attraction, and can only be so held by the attraction of some solid or liquid body; and on that basis make at first some figures which will show roughly the approximate magnitude that the earth's atmosphere would assume were that held by only one two-millionths part of the heft of the earth, or one two-millionths of its attraction. Under such circumstances, it woulds well to at least 2,000,000 times its present bulk. And if the air extends one hundred miles above the surface—which is probable—its volume is equal in round numbers to 20,000,000,000 cubic miles, which multiplied by 2,000,000 will show that our atmosphere under such conditions would swell so as to form a globe that in round numbers would contain 40,000,000,000,000,000 of cubic miles, and would be somewhat over half as large as the sun in diameter. And since the heft of the *atmosphere is about one-millionth* part of the heft of the whole earth, this combined mass of solid and gaseous matter would not weigh over three two-millionths ($\frac{3}{2000000}$) part of the heft of the earth. And since globes are in volume in proportion as the cubes of their diameter, a globe sixty-four times larger would be twice the diameter of the sun, and would *apparently* weigh but a little more than one ten-thousandth ($\frac{1}{10000}$) of the heft of the earth. I say *apparently*, but in reality it would weigh much less, because of another law, which forms an important factor in this case, that the heft of all bodies on the earth's surface, including its atmosphere, depends on the earth's attraction. And, if by the fiat of omnipotence that heft, without altering its volume, were increased between now

and morning, say 300,000 times, or nearly equal to the sun, it would increase the heft of all objects on its surface in proportion; the man who weighs to-day 150 pounds would to-morrow be crushed under his own weight of over 22,500 tons; our most substantial structure and material would be crushed to atoms by their increased gravity; and our hills and mountains would flow like liquid over the surface, and this increased pressure possibly might cause the whole planet to glow with heat like the sun.

On the other hand, if the weight of the solid parts of the earth were reduced to one two-millionth of its present heft, the heft of its atmosphere would be reduced in the same ratio, and if that solid part were again reduced to one sixty-fourth of one two-millionth of the solid earth, this atmospheric envelope would again swell at least sixty-four times, and form a globe that would be more than twice the diameter of the sun, and in heft many million times less than the earth, and too insignificant, if it were moving as a comet through the solar system, to appreciably affect by its attraction the movement of any of the bodies therein.

To show forth the probability that some comets may be composed largely of gas let us put in evidence the comet of 1770, whose visible nucleus, without counting its probable *undetected pure gaseous* envelope, was 203,000 miles in diameter, and it weighed, according to Laplace's computation, *less* (a term which leaves a wide margin) than one five-thousandth ($\frac{1}{5000}$) the heft of the earth. These are conditions which prove to almost a mathematical certainty that even the *visible* part of that comet must have been composed largely of gas.

Just what refractive effect such a globe of perfectly transparent gas, that varies from great density at its center to almost nothingness at its outer extremity, would have on the light of the sun when passing through it, is a matter difficult to dertermine either by theory or experiment. Would it gather that light to a focus beyond which it would be diffused in space? And would such focus be extended in a line of light? or would its refractive influence be such

as to gather the diverging rays of light, which it intercepts from the sun, and send them out in space in so nearly parallel lines that they would be able to carry nearly the same light and heat that the comet intercepts—however near the sun that may be—far out into space? Possibly each of these conditions may be correct; but each would depend on the size of the comet or its nearness to the sun.

The great comet of 1843 approached the sun so near that it passed through a heat that must have been nearly three and a half times hotter than that which the comet of 1680 passed through, which Newton computed to be 2,000 times hotter than red hot iron. Now, let it be granted that such a comet would be able to collect this heat and light so it would pass out in space in nearly parallel lines, the effect on this meteoric matter, which such a beam of light and heat would intercept when swinging in space, would be not only to make that dust visible because of its reflection of such brilliant light, but the dazzling light from such fusing heat on this matter might make it visible even at midday. Furthermore, if the tail of such a comet should envelope the earth for only a few minutes it would convert its exposed outer solid parts into gas or a molten fluid and explode its waters into vapor in the twinkling of an eye.

That some comets' tails are crooked or appear so, while light would certainly pass straight out in space, is an objection that does not militate in the least against this theory, that they are probably nothing but a streak of light which becomes visible by being cast on this dust; because the time required for the transmission of light, which is at the rate of 186,000 miles in a second, when considered in connection with the direction that the comet is moving in its orbit, whether that is in the plane that coincides, that is edgeways with our point of view, or whether that plane is perpendicular, or at a large angle to it, may explain the reason for the crooked appearance of the tails of some of the comets, or, in fact, the most of them. Because all except those which move in the plane of our vision would appear crooked, though many would be so little bent that

their crooked appearance would be undetected, some which are really short would appear straight, while others which look no longer would appear crooked, because they reach out beyond the comet from our point of view, perhaps hundreds of millions of miles, so far that many minutes would elapse—and in some cases perhaps hours—before we again see the light which passes through it reflected back from the extreme end of its tail. In the meantime, both the comet and the earth have been moving in their orbits, and we see this light that is reflected back to us from this extreme point in a different place from the light which streams out from immediately behind the comet.

The tail of the great comet of 1843 was over 200,000,000 of miles in length. In its perihelion that comet made one-half ot its circuit around the sun (180°) in less that two hours. If the orbit of that comet had been on a plane that was spread out perpendicular to our view, it would have taken the light 27.8 minutes after passing through it to reach the extreme end of its tail and return back as nearly to us as the comet. That is, we could not have seen the reflected light from this extreme limit until more than 27.8 minutes after it had passed through the comet, when we would have seen the light also streaming out immediately behind it. But the comet would have moved through 42 degrees of its orbit while this light was being transmitted out and back. Futhermore, all other conditions being the same, if such a comet had been moving in an orbit whose plane arose ten or fifteen degrees as that reached out from the horizon, and while making its perihelion passage, when it arrived at the culminating point—that is, in the middle of its arc above the horizon--the light which formed its tail would have streamed out so directly beyond the comet from our standpoint that it would have been thirty-five minutes after its passage through the comet before the reflected light from the extreme end of its tail would have returned back as nearly as the comet was to us. In the meantime, that would have moved fifty-two and a half degrees in its orbit. And we would have seen simultaneously the light which

had been passing through it during those thirty-five minutes spread out in the heavens in a brilliant bow that extended from the comet to the extreme end of its tail. Yet, at the same time, this light would have been streaming straight out in space, but it would have appeared to us bent, because of the difference in the time required for its transmission to and from every different mile of its length.

If these impressions as to what cause the streams of light which form the tails of comets be correct, we may safely speculate further, that when looking at them where they reach out directly from us, we would see so nearly the whole of the lighted parts of this matter, and so much greater an aggregation of their numbers covering a given space or cross section of our view, that it might enable us to see their tails extending many millions of miles further than when we view them at nearly a right angular position. And the tail of such a comet as that of 1843 might have been seen under such conditions extending millions of miles further. For its reflected light instead of fading from view because of its diffusion, when viewed from a point that was at a large angle with it, would, when viewed nearly on its line, have been concentrated within so small a radius that it might perhaps have been seen extending even hundreds of millions of miles further in space.

Again, the occasional broken appearance and changing brilliancy of some comet's tails would be the natural result of the projection of this excess of light on the varying density of this meteoric matter in space.

If some of these celestial globes of gas are enabled by their size to so concentrate the light of the sun which passes throught them that its rays are projected beyond in nearly parallel or but slightly diverging lines, then we may safely speculate that a gaseous lens of such gigantic proportion—if it has not already—may at some future time appear in our solar system that will be sufficiently powerful to project the light from our sun far beyond the most distant star that our telescopes brings to view. And since similar bodies are probably moving in orbits around all the visible fixed stars,

and the millions of invisible ones, too, which are beyond the reach of our telescopes, there is always a possibility that some of these wandering bodies may occasionally flash to *our* view the light they gather from even these more distant and unsuspected stars; some of which may be so vastly distant as to require hundreds of years for the transmission of their light to us which may be concentrated by such celestial *lense*.

The movements of such globes of gas, which project across space with but slightly diverging rays the light they gather from these distant suns about which they revolve—and the light they gather from other stars, too, when they happen to intervene between them and us—may explain the cause of the sudden increase in the brilliancy of visible fixed stars, which is known to have taken place. And, also, the phenomena of the occasional appearance of stars in the otherwise blank recesses of the heavens, one of which, in 1572, in Tycho Brahe's time, blazed forth with such brilliancy that it became visible at midday. In a short time after their appearance the places that all of these new stars occupied became again vacant on the map of the heavens.

It is not difficult to conceive that the movements of these gaseous bodies, and the movement of the earth as it may be carried by the sun with the whole solar system, may occasionally so coincide that we might remain for months within the blazing light that may be projected through some of these lenses from these distant suns. But it is impossible for me to conceive, with my knowledge of how slowly the light of our sun fades, how these blazing lights which occasionally appear—if they are caused by the collision of great suns—could, like an ephemeral bonfire, burn out and become extinguished in a few months or even in a few thousands or millions of years.